Brief Description of the Drawings

On page 3, after line 4, preceding the paragraph beginning with "In Figure 1,", please insert the following heading:

Detailed Description of the Preferred Embodiments

REMARKS

Claims 1-16 are pending in the present application. Claims 1-16 were rejected under 35 U.S.C. §101 and §112 1st paragraph. Claims 1-16 were also rejected under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 6,754,601 (Eryurek, *et al.*).

Applicant respectfully traverses these rejections.

Section 101 Rejections

Claims 1-16 were rejected under 35 U.S.C. §101 for the reasons presented in paragraph 3 of the Action. Although the rejection appears to be based on 35 U.S.C. §101 on lack of utility, the reasons relied upon by the Examiner appear to be based on the quality of the use rather than the lack of use.

Applicant urges that claims 1-16 are supported by a specific, substantial and credible utility for at least the reasons presented herein below.

Claims 1-16 are directed to methods and systems for "estimating the remaining lifetime of a device [machine]", including "collecting data on parameters contributing wear increments in a training set of sample devices until failure". Applicant urges that the process of "estimating the remaining lifetime of a machine" is by itself a 'utility' conforming to the "useful process, machine, or manufacture" clause of 35 U.S.C. §101. Whether the parameters used to make such estimations is well defined to enable such use is an issue of enablement or support, which are subjects rejectable under 35 U.S.C. §112, first paragraph, not 35 U.S.C. §101.

In any event, Applicant urges that the parameters of the relationships used to predict virtual age estimation are defined. In the exemplary embodiment disclosed in Applicant's specification, that of an x-ray tube, wear increment parameters are disclosed as including "any quantity affecting the rate of wear or ageing of the device, including directly measured physical quantities such as temperature or voltage or composite functions thereof such as, for example, power (product of voltage and current) or temperature difference, or e.g. control parameters such as load settings and time of operation." Because of the general applicability of Applicant's invention, the term "wear increment" can take on a more general meaning to include a change in "any quantity affecting the rate of wear or aging of a device", as recited on page 4 of Applicant's description, so as to have a broader range of applicability. For example, referring to the examples cited by the Examiner on page 5 of the Action, an exemplary wear increment for a semiconductor could be determined by a percentage of chemical change, an exemplary wear increment for a resistor could be determined by a change in a reliability function, etc.

In addition, the relationships provided in the specification do not require an explanation of the mechanisms of the various types of failures, only that a device fails. Referring to Applicant's non-limiting example of an x-ray tube, one skilled in the art of x-ray tubes will know how to characterize an x-ray tube failure, and will thus understand how to practice "collecting data on parameters contributing wear increments in a training set of sample devices until failure", as recited in claim 4. Similarly, referring to the Examiner's examples, one skilled in the art of tires will know how to characterize tire failure and what parameters to monitor, one skilled in the art of semi-conductors will

know how to characterize semi-conductor failure and what parameters to monitor, etc. Thus, contrary to the Examiner's assertion, there is no need to incorporate failure mechanisms into the relationships in Applicant's description. Further, there is no need to provide specification distribution functions since Applicant's methods involve collecting data or otherwise monitoring a training set of devices until failure.

Moreover, Applicant urges that all reliability failures can be expressible by wear increments, as discussed above. In addition, the variety of quantities included as wear increments preclude specifying units for every possible quantity. For example, the units of the components of the d-dimensional time-series measurement vector $\mathbf{x}_n$ could be different for each component. One skilled in the art of a particular device will know what quantities affect the rate of wear or ageing of a device, and will be able to supply the appropriate units. In addition, Applicant's discussion on page 5-6 of the description indicates, contrary to the Examiner's assertions, how the measurements of wear increments can be used to define a virtual age, and how the cumulative wear of a device of the same family as the training set can be used to estimate the elapsed fractional life of the device.

Thus, for the reasons presented above, Applicant urges that the invention claimed in claims 1-16 have a specific, substantial, and credible utility. Reconsideration and withdrawal of these section 101 rejections are respectfully requested

Section 112 Rejections

The Action rejected claims 1-16 under section 112, 1st paragraph stating that since the invention is not supported by a utility, one skilled in the art would not know how to use the invention. Applicant urges that, for the reasons stated above in connection with the section 101 rejections, the invention is supported by a specific, substantial, and credible utility, and that thus one skilled in the art would know how to use the invention. Thus, Applicant urges that the written description satisfies the requirements of section 112, 1st paragraph. Reconsideration and withdrawal of these rejections are respectfully requested.

Section 103 Rejections

Applicant urges that independent claims 1, 4, 10, and 16 are not obvious over Eryurek for at least the reasons presented herein below.

At the very least, Eryurek does not disclose or suggest a method and apparatus for providing a virtual age estimation for devices of a given type that recites, e.g., "modeling a wear increment by a multivariate Hermite polynomial of degree *k*", as essentially recited in claims 1, 4, 10 and 16.

Eryurek discloses diagnostic circuitry for detecting degradation of a resistive element of a process device while the process device remains online. The section of Eryurek cited by the Examiner, col. 9, lines 35-49, discloses curve fitting a polynomial function of a difference D between a reference voltage change and a measured voltage change, and using this function to estimate the lifetime of the device. The Examiner

concedes that Eryurek does not teach the use of Hermite Polynomials, but alleges that because Applicant does not provide a specific reason for the use of a Hermite Polynomial, it would be obvious to one skilled in the art to obtain a best fit from any polynomial.

Applicant respectfully disagrees. As stated by the Examiner on page 7 of the Action, Hermite Polynomials are solutions to Hermite's differential equation, which arises from Sturm-Liouville boundary value problems. Applicant urges that this property of Hermite Polynomials teaches away from their use for modeling wear increments. In particular, Hermite Polynomials are defined over the domain $(-\infty,\infty)$, whereas modeling the wear increment of a device is an initial value problem since the modeling starts at a finite time in the past, such as when a device is installed, and proceeds forward in time. This finite starting time can be taken, without loss of generality, as being time 0. This type of boundary condition suggests seeking a modeling polynomial defined on the domain $(0,\infty)$, or even on a finite domain since a device has a finite lifetime. Thus, this type of boundary condition teaches away from modeling with a polynomial defined over the domain $(-\infty,\infty)$ such as Hermite Polynomials. Furthermore, proceeding in the manner suggested by the Examiner, namely fitting any polynomial to the data and obtaining appropriate coefficients using a least squares method, is unlikely to yield Hermite Polynomials, a specific set of orthogonal polynomials, as a result. At best, one would obtain a single polynomial function proceeding as suggested by the Examiner, and it is highly improbable that an arbitrary data set would yield a polynomial that is a Hermite Polynomial. Thus, one skilled in the art would have no reasonable expectation of success of obtaining Hermite polynomials as a result of a least squares fit.

For the reasons presented above, Applicant urges that the Eryurek does not disclose or suggest all "modeling a wear increment by a multivariate Hermite polynomial of degree *k*", as essentially recited in claims 1, 4, 10 and 16. In addition, there is no reasonable expectation that one would successfully obtain a Hermite Polynomial by fitting a polynomial to a data set as suggested by the Examiner. Thus, Applicant urges that a *prima facie* case of obviousness of claims 1, 4, 10, and 16 over Eryurek cannot be maintained. Reconsideration and withdrawal of these section 103 rejections are respectfully requested.

Claims 2-3, 5-9, and 11-15 depend from claims 1, 4 and 10, respectively, and are thus patentable for at least the same reasons as claim 1, 4 and 10. Reconsideration and withdrawal of these rejections are respectfully requested.

CONCLUSION

Applicant urges that claims 1-16 are in condition for allowance for at least the reasons stated. Early and favorable action on this case is respectfully requested.

Respectfully submitted,

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By: Michele L. Conover

Michele L. Conover
Reg. No. 34,962

Siemens Corporation
Customer No. 28524
(732) 321-3191